LUND UNIVERSITY

Faculty of Science

# FYSB11, Physics: Basic Quantum Mechanics, 7.5 credits

*Fysik: Grundläggande kvantmekanik, 7,5 högskolepoäng*

**First Cycle / Grundnivå**

## Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2015-10-15 and was last revised on 2015-10-15. The revised syllabus applies from 2016-01-01, spring semester 2016.

## General Information

The course is an elective component of the Bachelor's programmes in science, and a compulsory component of a Bachelor of Science degree in Physics and of the Medical Physics study programme.

*Language of instruction:* English

| *Main field of studies* | *Depth of study relative to the degree requirements* |
|---|---|
| Physics | G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements |

## Learning outcomes

The objective is that the students, on completion of the course, shall have acquired the knowledge and skills within basic quantum mechanics required for continued studies of quantum physics.

The learning outcomes listed below relate to the general outcomes in the Higher Education Ordinance (1993:100).

### Knowledge and understanding

On completion of the course, the students shall be able to

1. describe the fundamental properties of quantum particles and explain key concepts such as wave-particle duality, wave function and superposition

2. set up and qualitatively justify the Schrödinger equation

3. explain and provide examples of how the operators in quantum mechanics are used to represent observable physical quantities

4. for a measurement of a quantum particle, formulate expressions for, and explain, key concepts such as probability, outcome, expectation value and uncertainty

5. deduce the radial parts of the Schrödinger equation for a spherically symmetric potential

### Competence and skills

On completion of the course, the students shall be able to

6. solve the Schrödinger equation for an infinite potential well in one dimension and describe the essential features of the solution and its characteristics for a finite potential well

7. calculate the probability for, and describe the qualitative characteristics of, transmission through simple potential structures in one dimension

8. deduce basic operator relations and perform simple calculations using the operators

9. formulate the Schrödinger equation for the harmonic oscillator in one dimension in terms of ladder operators, and calculate and describe the key characteristics of wave functions and eigenvalues of energy,

10. describe in writing a phenomenon with connections to the course in a conceptual way with a target group in upper secondary school

11. use numerical methods to solve quantum mechanics problems

### Judgement and approach

On completion of the course, the students shall be able to

12. assess which situations require a quantum mechanical approach

## Course content

The course covers basic quantum mechanics. In particular:

- wave-particle duality, superposition and wave function
- the Schrödinger equation
- bound state in one dimension
- spreading towards potential structures in one dimension
- operators, observables and operator relations
- measurements, expectation values and uncertainty
- harmonic oscillator
- spherically symmetric systems

## Course design

The teaching consists of lectures, calculation exercises and associated compulsory computer exercises and written assignments.

## Assessment

The assessment is based on:

- compulsory written assignments – assessment of all learning outcomes
- compulsory computer exercises – assessment of learning outcome 11 in particular
- project on conceptual description of quantum physics - assessment of learning outcome 10 in particular
- a written or oral exam at the end of the course – assessment of all learning outcomes.

*Subcourses that are part of this course can be found in an appendix at the end of this document.*

## Grades

Marking scale: Fail, Pass, Pass with distinction.
For a grade of Pass on the whole course, the student must have passed the reports for compulsory components and the exam.

## Entry requirements

To be admitted to the course, students must meet the general entry requirements and have physics knowledge equivalent to FYSA01 General Physics, 30 credits, as well as mathematics knowledge equivalent to 37.5 credits including the courses NUMA01 Computational Programming with Python, 7.5 credits, and MATB22 Linear Algebra 2, 7.5 credits.

# Subcourses in FYSB11, Physics: Basic Quantum Mechanics

Applies from V16

1501 Exam, 5,5 hp
Grading scale: Fail, Pass, Pass with distinction
1502 Laboratory exercises and Projects, 2,0 hp
Grading scale: Fail, Pass